RG104 E-1 Box 126 Feb-June 1882

Francis Fell
Mgr. Mason Elec Lgt Co
W. 120 Broadway
New York and
Electric

University of Pennsylvania.

Philadelphia April 24th 1882.

To John L. Leconte, M.D.

Chief Clerk U.S. Mint, Phila.

Sir: In accordance with the instructions contained in your letter of March 14th, I submit to you herewith the results of the experimental investigation of the system of electric lighting now in use at the Mint.

Very Respectfully

George F. Barker.

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Report.

1. Description of the Plant.

The apparatus employed at the Mint for the production of the Electric Light is as follows:

First:- Engine and Shafting. The Engine is of the Porter-Allen high speed type, and has a cylinder measuring nine by sixteen inches. It is rated at 50 horee power. It receives its steam from the general boiler supply of the Mint.

The power is transmitted from the fly-wheel of the engine to the main shaft by means of a 12 inch belt. From this shaft other belts pass to two counter shafts, having fast and loose pullies. These counter shafts are belted directly to the dynamo machines.

Second:- Dynamo-electric machines. Two distinct sets of dynamo-electric machines are in use, one intended to furnish a current of low tension for the incandescent lamps, the other to give a current of higher tension for the arc lamps.

The incandescent circuit contains two maximm machines of different sizes. The larger one furnishes the current to the lamps. It is wound with a double set of coils, the two sides being connected in multiple circuit. The smaller one generates a current to

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magnetize the field of the larger machine. A maxim regulator is attached to it, which is not in use. The arc circuit is maintained by two maxim machines of medium size, coupled together in series.

Third: Lamps. Upon the incandescent circuit are sixty-five maxim incandescent lamps arranged in multiple arc. They are distributed about in the various rooms of the building. Upon the arc circuit ten Weston arc lamps are placed, all arranged in a single series.

2.=Measurement.

A. Of Power.

The horse power developed by the engine was measured by means of the Tabor indicator. The indicated horse power, under the conditions of the trial, which are especified, was found to be as follows:—

Friction of Engine and shafting	6.52
Absorbed by incandescent machines	10.48
absorbed by Arc machines	14.57
Total horse power developed	31.57

Distributing the friction of the engine and shafting between the two sets of machines pro rata, the gross horse power consumed by each is found to be:—

For the incandescent machines	13.21
For the arc machines	18.36
Total Horse-power as above.	31.57

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3.= Results.

A:- Efficiency of Machines.

The efficiency of a dynamo-machine is the ratio of the current=energy it delivers to the power required to drive it. From the data above given, the efficiency of the two incandescent dynamos taken together may be calculated. The indicated horse=power required to drive them is 13.21. The yield of current is in mechanical measure, 6.11 horse powers. The ratio of these numbers $\frac{6.11}{13.21}$, or 0.466. represents the efficiency of the two machines. Expressed in percentages, these machines convert 46.60 per cent of the energy applied to them as indicated horse=power, into the energy of an electric current.

B. Efficiency of Lamps.

The efficiency of a lamp is the ratio of the light energy it gives out to the mechanical energy it absorbs. Since from the above data, 13.21 indicated horse=powers were absorbed to maintain 65 fifteen candle lamps, each lamp required $\frac{13.21}{65}$, or 0.203 horse=power to maintain it. Hence the number of such lamps maintained by one indicated horse=power is 4.92. As the average candle=power of these lamps was 15, the number of candle=lights obtained per indicated horse=power is 15 X 4.92, or 73.8. The ten arc lights required, as above, to maintain them, 18.36 horse=powers; a consumption of 1.836 horse=powers per lamp. Since each of these lamps

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gave a light of 416 candles, the efficiency is $\frac{416}{1886}$, or 226. In other words, these arc lamps gave 226 candle lights per indicated horse-power

4. Cost.

A. Of Power.

The cost of the Electric Lights to the Mint is obviously only a question of the cost of the steam power expended. The data at hand for the determination of this cost, are at best, only approximate. The following may be assumed as probably as fair an estimate as can be obtained.

1st. Engine:- Chief Engineer John L. M'Ginnis estimates the cost of the engine for one hour to be as follows:

240 lbs of coal @ $4.99 pr ton	0.53½
1 pint lubricator @ 50¢ per gallon	0.06¼
Engineer @ $2.75 per day	0.34⅜
Total cost of Engine	0 94⅛

2nd. Plant: The cost of the entire plant is assumed at $6000, and it is supposed to be in use for four hours each day. The cost for one hour is as follows:

Interest @ 6% $1.20 pr day, pr hour	0.30
Depreciation @ 2% 0.40 pr day, pr hour	0.10
Insurance @ 1% 0.20 pr day, pr hour	0.05
Total cost of plant.	0 45

3rd. Lamps, etc:- The lamps are supposed to have a life of 600 hours, and to cost one dollar each. Upon

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this basis, the cost of 65 lamps for one hour may be estimated at 0.11

Brushes. 0.02

Total cost of lamps and brushes. 0.13

The estimated cost to the Mint, then, of the steam-power for one hour is:—

For the Engine 0.94

For the Plant 0.45

For lamps and brushes. 0.13

Total cost. — — 1.52

The horse power developed by the engine, as shown by the indicator, was 31.57. Dividing $1.52, the cost per hour by this value, the quotient is 4.8 cents, the cost of one horse-power. The probable cost to the Mint, therefore, of one horse-power for one hour may be assumed as not far from five cents.

B:— Of Light:

1st. Incandescent Light. As proved above, each maxim incandescent lamp, when giving a light of 15 candles, consumes 0.203 horse power. Since the cost of one horse power is now assumed to be five cents, the cost of maintaining a single lamp will be 1.015 cents. Or, to reverse the statement, the incandescent system of the Mint furnishes 14.8 candle lights for one hour for each cent of expenditure

2nd. Arc Light. According to the data given above, the expenditure of one horse-power upon an arc

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B. = Of Light.

The illuminating power of the lamps was measured on a Bunsen photometer, in terms of Lugg standard candles. The incandescent lamps were measured with the plane of the carbon filament at 45° to the length of the photometer bar; a position which gives the mean value of the illumination in a horizontal plane. Measured in this way the average candle power of the incandescent lamps was found to be 15. The total illuminating power on the circuit, therefore, is 15 X 65 = 975 candles.

The arc lamps when measured on the same photometer, were found to give 416 candles when naked, and 144 candles when enclosed in the ordinary porcelain shade. The ten lamps, consequently, give a total light of 4160 candles.

C. Of Current.

The current strength was measured upon a double coil tangent galvanometer previously calibrated In the incandescent circuit, the electrical current was found to be 91.2 ampères, having an electro-motive force of 50.1 volts. Consequently, the total energy of the current was 91.2 X 50.1, or 4569 volt-ampères. This is equivalent to a mechanical energy of 202178 foot-lbs. or about 6.11 horse powers. The current flowing in the arc circuit was found to have a strength of 37.8 ampères

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lamp yields a light of 226 candles. Since one horse power costs, on the estimate already made, five cents per hour, it follows that the arc system in use at the Mint yields the light of 45.2 candles for each cent expended.

5. Conclusion.

The relative cost of the electric light as compared with gas may be obtained from the figures which have now been given. On the assumption that an average gas jet burning five cubic feet of gas per hour, will afford a light of sixteen candles, it appears that 16 maxim incandescent lamps will give the same amount of light as 15 gas jets: that is, 240 candles. To burn 1000 cubic feet in one hour would require 200 of these gas burners, and the light emitted would be 3200 candles. But to give this amount of light by incandescence 213 maxim lamps would be required. As each lamp costs 1.015 cents to maintain it for one hour, the cost of maintaining the 213 lamps required to give the same light as is given by 1000 cubic feet of gas is $2.16.

In the case of the arc lights, the cost of 226 candle lights is given at 5 cents. To give 3200 candle lights, therefore, which is the equivalent of 1000 cubic feet of coal gas, the cost will be 70.8 cents.

In conclusion, assuming the correctness of the data which have now been given, as well as of the calculations founded upon them, it appears that the cost to

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the Mint, of the incandescent light, is the same as the cost of coal gas at $2.16 per thousand cubic feet. And the cost of the arc light is the same as that of coal gas which is furnished at 70.8 cents pr thousand cubic feet. The incandescent light, for an equal illumination, costs therefore a little more than gas. The arc light, on the other hand, is very considerably cheaper than gas, the quantity of light being the same in the two cases.

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Prof. Barker's
Opinion on the
Maxim light in
the Mint

NARA RG104, Entry 1, Box 126

[Abstract:] Prof. Barker's opinion on the maximum light in the Mint.

[Noted in margins:] Mr. Francis Gel.-Manager of U.S. – No. 120 Broadway
Without any – Exception –

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